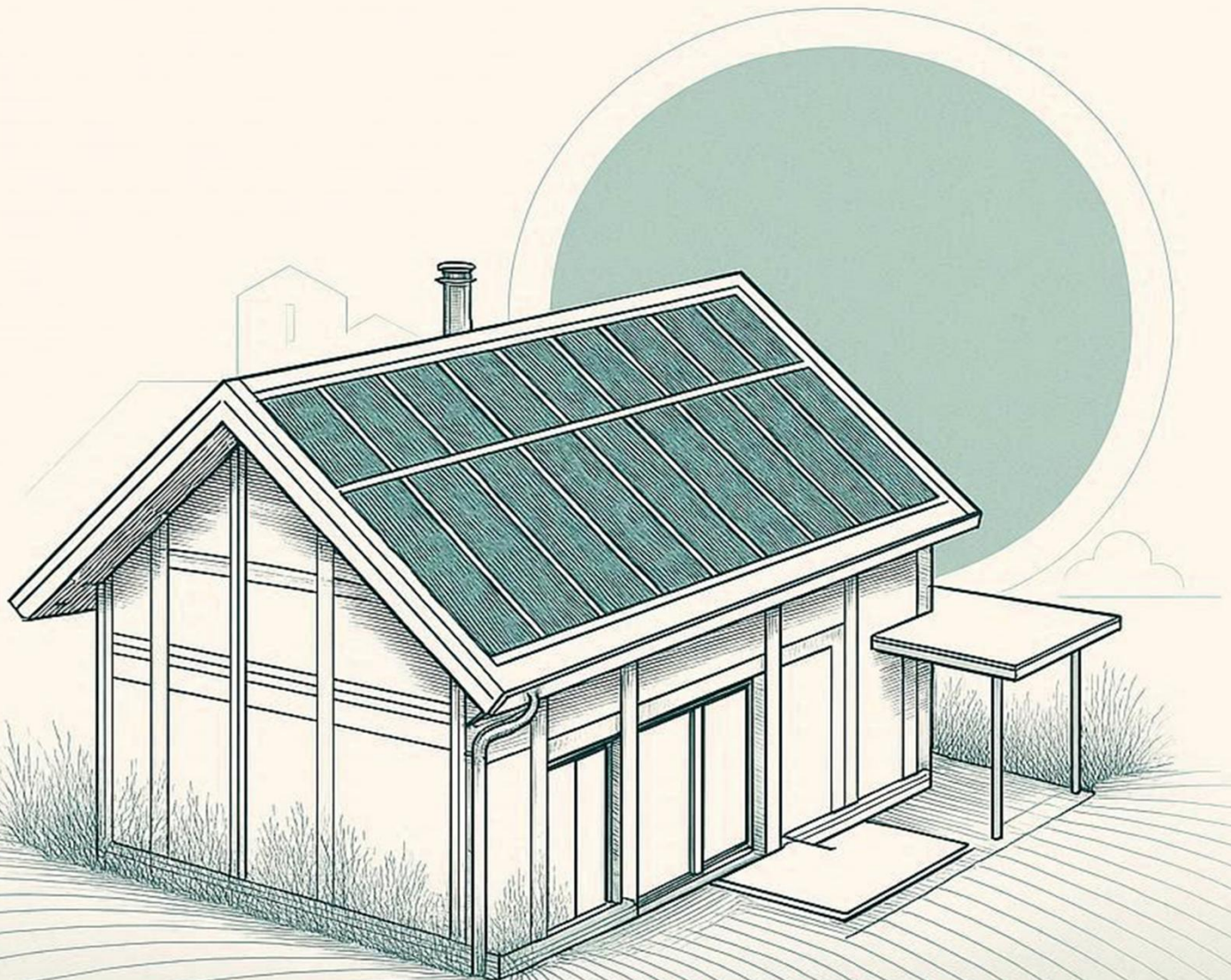


# Achieving Nearly Zero Energy Building (NZEB) Standards

Smart Optimization and Dynamic Performance Analysis of the 'Home for Life'



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**Publication Date: January 2026**

## Keywords:

Nearly Zero Energy Buildings (NZEB), Smart Energy Optimization, Dynamic Performance Analysis, Active House Standard, Thermal Mass & Building Envelope, TRNSYS Simulation, Lifecycle Carbon Neutrality, Adaptive Thermal Comfort (EN 15251), Renewable Energy Integration (BIPV), Thermal Comfort Indices (PMV/PPD)

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## Abstract

This research presents a comprehensive multi-dimensional analysis of energy efficiency and environmental sustainability within the "Home for Life" project, located in Lystrup, Denmark. The primary objective of this study is to achieve a carbon-neutral structure and, beyond that, an "Active House" capable of generating surplus energy. Utilizing TRNSYS software, the study investigates the synergistic impact of climatic parameters and passive design strategies across three distinct geographical contexts: Denmark, Italy, and Egypt.

The research methodology is based on a step-by-step optimization process encompassing a wide array of technological solutions. These include the thermal mass analysis of the building envelope (Heavy Masonry vs. XLAM systems), dynamic shading strategies, mechanical ventilation with heat recovery (Air-to-Air and ground-to-Air), and the integration of active heating/cooling systems alongside photovoltaic (PV) arrays. The findings demonstrate that by intelligently merging passive and active strategies, not only are thermal comfort hours significantly increased (based on EN 15251 and UNI 7730 standards), but the building also achieves a 23% reduction in annual energy consumption. Moreover, the surplus electricity generated during warmer months allows the structure to attain a positive energy balance and offset its material carbon footprint over a 35-year lifecycle. This project serves as a pioneering model in sustainable architectural design, where the building evolves from a mere consumer into a long-term environmental asset.